

## REMARKS

Claims 1-7 and 9-13 are pending in the present Application. Claims 1, 7 and 10 have been amended, Claims 6, 8 and 9 are cancelled, and Claims 4 and 11-13 are withdrawn from consideration leaving Claims 1 - 3, 5, 7, and 10 - 13 for consideration upon entry of the present Amendment.

Support for the amendment to Claim 1 can be found in at least in Claims 6 and 9 as originally filed.

Claim 1 has been amended to better define the invention. The bidentate ligand of Formula 1 is limited so that X is now oxygen and R1 and R2 are heterocycles. The transition metal of the catalyst is limited to rhodium. As noted above, Claim 9 is incorporated into Claim 1 in which the relative contents for the bidentate and monodentate ligands are specified as a means for controlling the N/I (normal/iso-aldehyde) selectivity.

Claims 7 and 10 have been amended to provide the proper antecedent basis.

Reconsideration and allowance of the claims are respectfully requested in view of the above amendments and the following remarks.

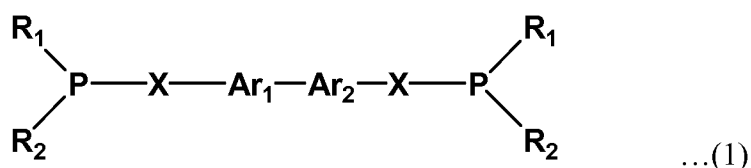
### Claim Rejections Under 35 U.S.C. § 103(a)

Claims 1-3, 5-7, 9 and 10 stand rejected under 35 U.S.C. § 103(a), as allegedly unpatentable over U.S. Patent No. 6, 153,800, by Gelling et al. (hereinafter "Gelling") in view of "Organometallics, 2002, 3873-3883" by van der Slot et al. (hereinafter "van der Slot"). Applicants respectfully traverse this rejection.

For an obviousness rejection to be proper, the Examiner must meet the burden of establishing that all elements of the invention are disclosed in the prior art; that the prior art relied upon, or knowledge generally available in the art at the time of the invention, must provide some suggestion or incentive that would have motivated the skilled artisan to modify a reference or combined references; and that the proposed modification of the prior art must have had a reasonable expectation of success, determined from the vantage point of the skilled artisan at the time the invention was made. *In re Fine*, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988). The obviousness inquiry also requires consideration of common knowledge and common sense. *KSR*

*Int'l Co. v. Teleflex Inc.*, 127 S.Ct. 1727, 1742-43 (2007); *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1367 (Fed. Cir. 2006) (“Our suggestion test is in actuality quite flexible and not only permits, but requires, consideration of common knowledge and common sense.”)

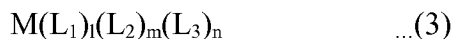
Claim 1 as presently amended is directed to a catalyst composition for hydroformulating an alpha-olefin compound comprising a bidentate ligand represented by formula 1, a monodentate ligand represented by formula 2, and a transition metal catalyst represented by formula 3:



wherein each of R<sub>1</sub> and R<sub>2</sub> is a substituted or unsubstituted C4-36 heterocyclic group, Ar<sub>1</sub>-Ar<sub>2</sub> is a bisaryl compound, and X is oxygen (O),



wherein each of R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub> is a substituted or unsubstituted C1-20 alkyl group; a substituted or unsubstituted C1-20 alkoxy group; a substituted or unsubstituted C5-20 cycloalkane or cycloalkene; a substituted or unsubstituted C6-36 aryl group; a substituted or unsubstituted C1-20 heteroalkyl group; a substituted or unsubstituted C4-36 heteroaryl group; or a substituted or unsubstituted C4-36 heterocyclic group, each of R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub> being optionally substituted with nitro (-NO<sub>2</sub>), fluorine (F), chlorine (Cl), bromine (Br), or a C1-4 alkyl group,

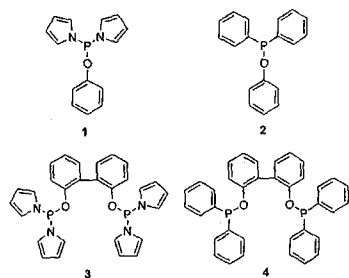


wherein M is rhodium, each of L<sub>1</sub>, L<sub>2</sub> and L<sub>3</sub> is hydrogen, CO, acetylacetonato, cyclooctadiene, norbornene, chlorine, or triphenylphosphine, and each of l, m and n is a number of 0 to 5, provided that all l, m and n are not zero simultaneously; and wherein the concentration of rhodium is 50 to 500 ppm based on the amount of the catalyst composition, and per mole of the rhodium,

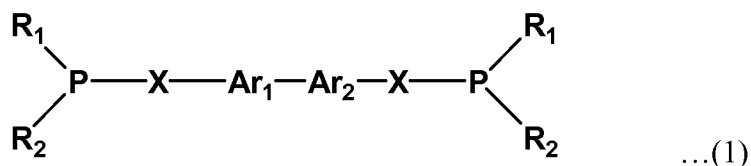
the concentration of the monodentate ligand is 0.1 to 10 mol and the concentration of the bidentate ligand is 0.5 to 2 moles to give a N/I selectivity of 2 to 3, or 3 to 10 moles to give a N/I selectivity of 15 to 18.

Van der Slot teaches using bidentate phosphorous amidite and phosphinite ligands with a rhodium catalyst. (See title and see abstract) In particular, Van der Slot teaches the following structures in its Scheme 1 shown below:

**Scheme 1. Monodentate and Bidentate Phosphorus Amidite and Phosphinite Ligand Structures**



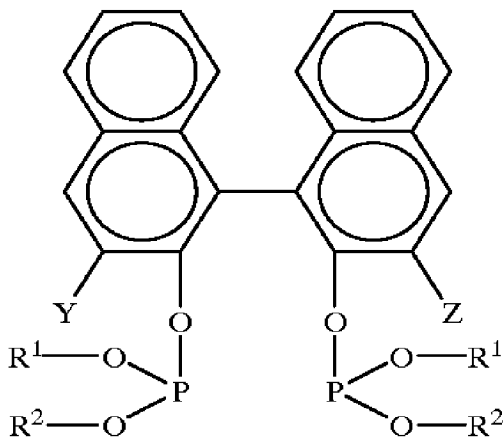
Van der Slot does not teach a monodentate phosphine ligand ( $P(OR)_3$ ). Van der Slot only teaches the use of multidentate phosphinite ligands ( $P(OR)R_2$ ). Van der Slot does not teach a bidentate ligand represented by formula 1:



wherein each of  $R_1$  and  $R_2$  is a substituted or unsubstituted C4-36 heterocyclic group,  $Ar_1-Ar_2$  is a bisaryl compound, and X is oxygen (O). Van der Slot thus does not teach all elements of the claimed invention.

Gelling teaches a catalyst system comprising a monodentate phosphine ligand, a bidentate phosphate ligand and a suitable rhodium or iridium compound. (See Abstract and see Col. 6, lines 23 – 25) However, the bidentate ligand disclosed by Gelling does not contain a heteroatom as is presently claimed.

In particular, Gelling teaches a multidentate phosphite ligand



where R<sup>1</sup> and R<sup>2</sup> are independently two organic monovalent aryl groups and/or one divalent diaryl group. (See Col. 3, lines 62 - 63)

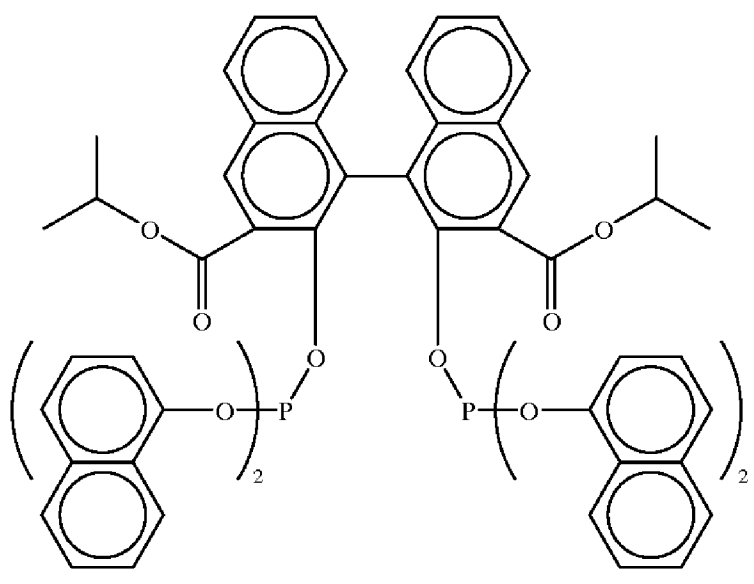
In particular, Gelling teaches that

R<sup>1</sup> and R<sup>2</sup> are preferably monovalent organic groups with 1 to 20 carbon atoms or R<sup>1</sup> and R<sup>2</sup> form together one divalent organic group having 6 to 30 carbon atoms. Most preferably, R<sup>1</sup> and R<sup>2</sup> are monovalent aryl groups having 6 to 14 carbon atoms. The different R<sup>1</sup> and R<sup>2</sup> groups in the ligand may be different. For example in the same ligand some groups R<sup>1</sup> and R<sup>2</sup> may be divalent groups while other groups R<sup>1</sup> and R<sup>2</sup> are monovalent groups.

(See Col. 3, line 64 - Col. 4, line 4)

In neither of these descriptions does Gelling describe the aryl groups as being heteroatoms.

In its examples, Gelling depicts one embodiment of the multidentate phosphite ligand as follows:



Here too, the aryl groups of Gelling (that would be represented by  $R_1$  and  $R_2$  in the Formula (1) of the claimed invention) do not contain any heteroatoms.

Both Van der Slot and Gelling do not teach that  $R_1$  and  $R_2$  in the Formula (1) of the claimed invention contain heteroatoms in the C4-36 heterocyclic group. For this reason at least, neither Van der Slot nor Gelling teach all elements of the claimed invention.

The amended hydroformylation catalyst composition comprises a rhodium catalyst, and cocatalysts comprising a bidentate ligand with heterocyclic substituents and a monodentate phosphine-type ligand. The features that distinguish the present invention from the cited references are, (a) the simultaneous use of a phosphine-type monodentate ligand in addition to a bidentate phosphorus ligand with  $R_1$  and  $R_2$  being heterocycles and (b) the tuning of the product N/I ratio by controlling the relative contents for the two cocatalysts. The adoption of these two limitations is significant because it enables a tunable product selectivity coupled with high catalyst activity.

The Examiner has argued that the references teach replacing the bidentate ligand from the catalyst system of Gelling with that of van der Slot. However, NOTHING in Gelling suggests or mentions phosphoramidite type bidentate ligands (for example,  $BPO-P(pyl)_2$  of the present invention). The bidentate phosphorus ligands of Gelling are entirely based on phosphites. Furthermore, van der Slot forgoes the use of monodentate phosphorus ligands at all. Thus, there

is no motivation or suggestion to combine the particular phosphoramidite bidentate ligand of van der Slot with Gelling's catalyst system.

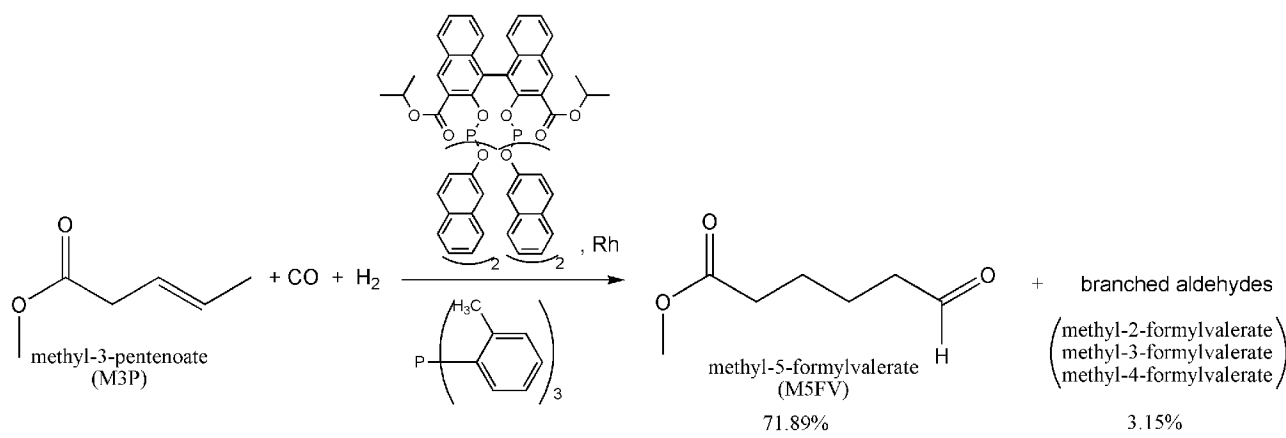
Even if we assume, for argument's sake, that such combination would have been obvious, it still falls short of the unexpected tunable product selectivity of the present invention. In short the claimed invention produces unexpected results.

The catalyst system of the present invention is capable of driving the product N/I ratio in either direction by simply controlling the relative amount of cocatalysts. Another significant characteristic is that the inventive catalytic system can produce **branched** aldehydes from common, **linear** olefin feed stocks ( $\alpha$ -olefins). It should be noted that the cited references are single-mindedly focused on driving the product aldehyde profile towards high N/I ratio (excess linear aldehydes over branched ones), but completely silent on the means for tuning the product selectivity in the opposite direction. For instance, Van der Slot states in the introduction that "a suitable combination of steric and electronic properties ..... might increase both the activity and selectivity" for the "linear aldehyde".

Gelling describes that the simultaneous use of monodentate ligands along with the bidentate ligands to achieve high selectivity for linear aldehydes, "was unexpected, because monodentate phosphines are well known ligands and it was expected that by adding these extra ligands the selectivity to (linear) aldehyde compounds would be adversely effected". (See Summary of the Invention)

In other words, both references are predicated on the idea that achieving more linear aldehydes (*i.e.*, a higher N/I ratio) is desirable. On the other hand, the present invention provides a catalyst system that can be readily switched to high concentrations of either linear aldehydes or branched aldehydes.

Let's compare in detail the control of N/I product selectivity between the present invention and the references. Since van der Slot does not employ monodentate ligands, one cannot meaningfully compare the control of product N/I ratio between the present invention and van der Slot. If one examines Gelling, it is found that Gelling's system is even more driven towards linear aldehydes. The following reaction formula summarizes the results from example 1 of Gelling.



such reaction conditions as temperature and reaction time so affect the N/I ratio. The applicant stresses that the N/I ratio specified in claim 1 is to be understood as the best

The N/I ratio of 22.8 (=71.89/3.15) is quite high and this high linear selectivity is all the more notable since Gelling produces a *linear aldehyde* (M5FV) from an *internally unsaturated* olefin (M3P). Such use of internally unsaturated olefin feedstocks for producing linear aldehydes is a distinguishing characteristic of Gelling and is amply demonstrated, for example, see column 4, lines 14-19, column 6, lines 42-67 and column 7, lines 20-37. The monodentate/bidentate (m/b) ratio for Gelling's catalyst system at the N/I value of 22.8 is 5 (see example 1). This contrasts sharply with the present invention's m/b ratio of 1/5 at a comparable N/I value of 17.2 (Table 1, present invention). In fact, in the examples of the present invention, the N/I value falls down to the branched aldehyde region when m/b ratio is equal to or more than 5.

The significance of limitation (b) lies therein; when combined with limitation (a), it provides a technical means for accessing the region of low N/I ratios (branched aldehydes) without using branched starting materials but from more readily available straight (linear) olefin feedstocks. None of the cited references, however, mention, suggest or much less teach a catalyst system with N/I ratios tunable over such a wide range.

Thus, the two limitations (a) and (b) defined above, distinguish the claimed inventions from the cited references and the present invention is unobvious over these references. Since both Gelling and Van der Slot do not teach all elements of the claimed combination and since there is no motivation to combine references, the Applicants believe that the Examiner has not made a prima facie case of obviousness over Van der Slot in view of Gelling. The Applicants respectfully

request a withdrawal of the obviousness rejection and an allowance of the claims.

**Conclusion**

It is believed that the foregoing amendments and remarks fully comply with the Office Action and that the claims herein should now be allowable to Applicants. Accordingly, reconsideration and allowance are requested.

If there are any additional charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130.

Respectfully submitted,

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